

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Fisher, et al
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For:	Thermodynamic Energy Conversion Devices And Methods Using A Diamond- Based Electron Emitter
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*#6
PCT/PTC
C. Fisher
8-28-02*

PRELIMINARY AMENDMENT

Box PCT
Commissioner of Patents
and Trademarks
Washington, DC 20231

Dear Sir:

Applicant is filing this Preliminary Amendment upon entry
into the National Stage of PCT/US00/40921.

No amendment has been made to the claims. Only a
sequential numbering problem has been corrected.

In the Claims:

Please cancel claims 1-26 and enter the following new claims.

~~27~~²⁷ An energy conversion device adapted to enhance field emission, comprising:

a diamond emitter adapted to utilize band bending to emit a high-energy distribution of electrons to produce an energy conversion effect.

~~28~~²⁸ The energy conversion device of claim ~~27~~³⁰, the diamond emitter including a geometric tip enhancement.

~~29~~²⁹ The device of claim ~~28~~³¹, the geometric tip enhancement comprising:

micro-nanoscale tips on the cathode emitter.

~~30~~³⁰ The device of claim ~~28~~³¹, the geometric tip enhancement comprising:

a conical tip shape.

~~31~~³¹ The device of claim ~~28~~³¹, the geometric tip enhancement comprising:

a pyramidal tip shape.

~~32~~³² The device of claim ~~28~~³¹, the geometric tip enhancement comprising:

a hydrogen tip termination.

~~33~~³³ The energy conversion device of claim ~~27~~³⁰, the diamond emitter including a polycrystalline structure with sp² bonding.

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~~27~~

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34. The energy conversion device of claim 27, the diamond emitter including dopants that produce band bending via space charge accumulation.

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35. The energy conversion device of claim 27, the dopant selected from a dopant group including as nitrogen, phosphorous, and sulfur-hydrogen.

39
36. An electronic cooling device, comprising:
a cathode comprising at least one emitter structure on a base;
and

an anode positioned over and spaced apart from the cathode by a vacuum space,

a biasing energy supply adapted to bias the cathode to anode separation, the bias of sufficient potential to cause electron emission from the base electrode through the cathode into the conduction band, then through the vacuum and deposition in the anode;
the emitter structure including a diamond microtip emitting portion.

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37. The electronic cooling device of claim 36, the diamond microtip emitting portion including a geometric tip enhancement for enhancing band bending.

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38. An electronic cooling device, comprising:
a cathode comprising at least one emitter structure on a base, the emitter structure including a diamond microtip emitter extending upwardly from and formed integral to a diamond substrate having a top surface;

an anode layer spaced apart from the emitter and suspended above the diamond substrate by a first insulating layer extending upwardly from the top surface of the diamond substrate;

a porous gate positioned above and spaced apart from the diamond microtip, supported by a second insulating layer extending upwardly from a top surface of the anode layer; and

a biasing energy supply adapted to bias the anode and the gate separation, the bias of sufficient potential to cause electron emission from the base electrode through the cathode into the conduction band, then through the vacuum and deposition in the anode.

39. The device of claim ~~38~~⁴¹, the porous gate is constructed in a grid arrangement.

40. The device of claim ~~38~~⁴¹, the porous gate is constructed in an annular gate structure adapted to provide appropriate electrical conditions for cathode emission, while also providing a path to the anode.

41. The device of claim ~~38~~⁴¹, wherein the bias between the cathode and the anode is maintained at a higher level than that of the bias between the cathode and the gate, but the bias between the cathode and the anode still allows electrons emitted from the cathode to reach the anode.

42. A method for energy conversion using a diamond microtip cathode separated from an anode by a vacuum space, the method comprising:

shifting the field emission band with a positive voltage bias on the anode to narrow the potential barrier width to increase the

probability of quantum tunneling to increase field emission and produce a transfer of thermal energy from the cathode to the anode.

43. The method for energy conversion of claim 42, wherein shifting the field emission band occurs in the cathode.

44. The method for energy conversion of claim 42, the shifting occurring near the base-electrode/cathode interface

45. The method for energy conversion of claim 42, wherein shifting the field emission band occurs in the vacuum.

46. The method for energy conversion of claim 42, the shifting occurring near sp²-bonded elements of the polycrystalline structure.

47. The method for energy conversion of claim 42, the shifting occurring at the cathode/vacuum barrier

48. The method for energy conversion of claim 42, further comprising:

decreasing the resistance to electron flow between the cathode and anode through the use of a gate electrode designed to extract electrons from the cathode while allowing emitted electrons to bypass the gate.

49. An energy conversion structure, comprising:
a biased diamond microtip emitter thermally and electrically connected to a base and spaced from an anode by a vacuum gap, the biased microtip emitter forming curved energy bands adapted to produce a net energy transfer to an anode.

50. The energy conversion structure of claim 49, the net energy transfer manifest as cooling of the base.

51. The energy conversion structure of claim 49, the net energy transfer manifest as power generation with an electrical potential between the anode and the base.

52. A step for improving efficiency for an energy conversion device using a base electrode and a diamond emitter cathode, the step for improvement comprising:

providing geometric enhancement adapted to increase the local electric field at the interface between the base electrode and the diamond cathode.

53. A diamond emitter energy conversion device adapted to provide power to an external circuit, comprising:

a cathode with a microtip structure, the cathode adapted to support a high density of energetic electrons and further adapted to be electrically connected to the external circuit;

an anode spaced from the cathode and adapted to be electrically connected to the external circuit;

an annular gate electrode adapted to provide a low potential field sufficient for emission of electrons from the cathode tip to the anode by bypassing the annular gate; and

a biasing energy supply adapted to bias the anode and the gate separation, the bias of sufficient potential to cause electron emission from the base electrode through the cathode into the conduction band, then through the vacuum and deposition in the anode.

54. A method for increasing efficiency of energy converters utilizing a thermal differential across a structure including a base